candles in June to 3,600 foot-candles in January. It is less than the direct solar illumination on a normal surface from September to February, inclusive, but exceeds the latter from May to August, inclusive, for a period of from four to eight hours in the middle of the day.

The illumination on a horizontal surface from a completely overcast sky may be half as great as the total illumination with a clear sky, and is frequently one-third as great. On the other hand, during severe thunderstorms at noon in midsummer, the illumination may be reduced to less than one per cent of the illunimation with a clear sky.

The ratio of sky-light illumination to total illumination on a horizontal surface at noon in midsummer varies from one-third to one-tenth. In midwinter it varies from one-half to one-fifth.

When the sky is clear the twilight illumination on a horizontal surface falls to 1 foot-candle about half an hour after sunset, or when the sun is about 6° below the horizon.

REFERENCES.

(1) **Sharp, Clayton H. & Millar, Preston S.** A new universal photometer. Electrician, 1908, **60**:562–565.

(2) *See* Bulletin of the Mount Weather Observatory, 1913, v. **6**, pt. 5, p. 218–219; and MONTHLY WEATHER REVIEW, March, June, and September, 1914, **42**:139, 310 and 520.

(3) MONTHLY WEATHER REVIEW, August, 1914, **42**:480.

(4) Annals of the Astrophysical Observatory of the Smithsonian Institution, Washington, 1913, **3**:135–138.

Smithsonian Physical Tables, 6th ed., 1914, p. 182.

HEAT FROM THE STARS.[1]

In the MONTHLY WEATHER REVIEW for June, 1914 (p. 347), were presented some figures expressing the amount of heating at the earth's surface which may properly be attributed to the radiation received from the planets of the solar system. Equally interesting is the similar question concerning the stars, those innumerable suns lying far beyond our own prime source of heat and energy. Among others Dr. W. W. Coblentz has attacked this problem, and first by constructing an exceedingly delicate radiometer. His instrument is essentially a bismuth–platinum, or a bismuth–bismuth plus tin alloy thermocouple exposed in a high vacuum. He has measured the radiation from 105 stars, among other celestial objects, and finds "that red stars emit from two to three times as much total radiation as blue stars of the same photometric magnitude."

Measurements were made on the transmission of the radiations from stars and planets through an absorption cell of water. By this means it was shown that, of the total radiation emitted, the blue stars have about two times as much radiation as the yellow stars, and about three times as much radiation as the red stars, in the spectral region to which the eye is sensitive. * * *

Measurements were made to determine the amount of stellar radiation falling upon 1 square centimeter of the earth's surface. It was found that the quantity is so small that it would require the radiations from Polaris falling upon 1 square centimeter to be absorbed and conserved continuously for a period of one million years in order to raise the temperature of 1 gram of water 1° C. If the total radiation from all the stars falling upon 1 square centimeter were thus collected and conserved it would require from 100 to 200 years to raise the temperature of 1 gram of water 1° C. In marked contrast with this value, the solar rays can produce the same effect in about one minute.

[1] **Coblentz, W. W.** A comparison of stellar radiometers and radiometric measurements on 110 stars. *Abstract in* Jour., Washington ac. sci., Washington, Jan. 19, 1915, 5: 33–34. *Detailed paper will appear in the Bulletin of the U. S. Bureau of Standards.*

E. KRON ON THE EXTINCTION OF LIGHT IN THE TERRESTRIAL ATMOSPHERE IN THE REGION OF THE ULTRA-VIOLET.[1]

By WILHELM SCHMIDT.

Kron's report deals with photographic-photometric observations, by means of a quartz spectrograph, on the brightness (Helligkeit) of the sun at the Astrophysical Observatory at Potsdam, Germany, during the years 1911 to 1913. The extraordinary range [Abstufungsmöglichkeit] permitted by the conditions of the experiments enabled the region of accurate measurements to include both the extraordinary differences in intensity in the different spectral regions (between wave-lengths $430\mu\mu$ and $310\mu\mu$) and the total solar intensity as related to its altitude above the horizon (measurements being possible down close to it). There is nothing new in the methods of computation which are based upon the Bouguer Formula and Bemporad's values for the air masses.

In general it appears that the coefficient of transmission p is subject to variations from day to day, while the observations for the same day show good agreement among themselves with departures due to increased absorption for the lowest solar altitudes as would be expected if masses of vapor occur. The mean values obtained by Kron are in part essentially lower than those secured in 1909 and 1910 by C. G. Abbot[2] on Mount Whitney; as the following comparison shows. The third column of values have been reduced to Potsdam barometric conditions by multiplying.

Values for the coefficient of atmospheric transmission, p, *by Kron (Potsdam) and Abbot (reduced to Potsdam).*

Wave length. λ	Kron's value for p.	Abbot's value for p (reduced).
μ 0.432	0.648	0.762
.390	.531	.678
.371	.464	.629
.341	.354	.531
.325	.268	.457

Since only the last of the Abbot values seems to have been increased by the action of diffused light in his instrument, it is at least evident that values determined for a high-level station can by no means be directly reduced to low-lying stations.

Rayleigh is the authority for the assumption that it is particularly the absorption in the region of the shortest wave-lengths (except certain bands, e. g. those due to ozone, below 0.325μ), which is produced by scattering from air molecules so that its amount is inversely proportional to the fourth power of the wave-length, λ. If one computes from Kron's observations the absorption-coefficients $C = \log \text{nat}\, p$, then they may be readily represented by a formula of the form

$$C = \frac{\alpha}{\lambda^4} + \beta,$$

where $\alpha = 0.01325$ and $\beta = 0.066$. The small value of β at once shows the formula closely in agreement with the above law, while this agreement is yet further improved

[1] A translation of a review in Met. Ztschr., Braunschweig, November, 1914, **31**: 555–6.—C. A. Jr.

[2] Annals of the Astrophysical Observatory of the Smithsonian Institution, vol. 3, Washington, 1914.

if one assumes that β expresses the absorption due to foreign constituents of the air which may be responsible for the day-to-day variations.

Now it is possible to demonstrate that Rayleigh's law holds good for these foreign constituents also, that they also function by molecular diffraction. Water vapor is the first to occur to us in this connection, and for this element F. E. Fowle [3] has already devised a formula similar to that previously suggested. Employing his figures and expressing the amount of the water vapor w in centimeters of the equivalent precipitated water, then $\alpha = 0.00889 + 0.00067w$, $\beta = 0.011w$, and these well represent the observations, particularly the general mean of all, with the exception of very slight variations.

Kron summarizes his results as follows:

The extinction in the region of the ultra-violet up to 0.325μ may be wholly explained by molecular diffraction, together with the absorption by water vapor which is itself chiefly due to molecular refraction as found by Fowle.

Beyond the wave-length 0.325μ his observations reveal an increase in the extinction which is probably due to the influence of the ozone band here beginning to make itself felt.

[3] Astrophysical journal, 1913, **38**: 392; Meteorol. Ztschr., 1914, **31**: 270. Monthly Weather Review.